



Prickly Pear Creek Trynan fish passage

# **Montana Fish, Wildlife & Parks**

November 30, 2017

Helena Area Resource Office  
930 W Custer Ave  
PO Box 200701  
Helena, MT 59620

FFIP Panel Members  
PO Box 200701  
Helena, MT 59620

Dear FFIP Panel Members,

I am writing for your support for funding a fish passage project on Prickly Pear Creek in the Helena valley. This project proposes to construct in-stream step-pool structures and a fish bypass channel to facilitate fish passage at an existing irrigation diversion dam, and to address heavily eroded banks that have been impacted by the diversion dam.

Fishery resources in Prickly Pear Creek in the Helena valley have improved substantially in the past decade thanks to improved water flows in the summer months, removal of a fish barrier south of East Helena, and installation of a fish ladder on a fish passage barrier in the central valley. This proposal addresses the final substantial impedance to fish passage in the Helena valley.

The diversion dam on the Tryan property is a partial barrier to fish passage during the non-irrigation season (when check boards are out), and is a full barrier during irrigation season. When the boards are out a few larger sized fish can overcome the height and velocity barrier caused by the structure to move upstream. The structure is too high for any fish to pass when the boards are in place.

There is presently a robust resident population of brown trout that reside above the diversion, but only a handful of migratory rainbow trout are able to pass the structure in the spring, and no migratory brown trout are able to pass in the fall because either the check boards are still in place or flows are too low to negotiate the diversion structure. Migratory trout moving upstream from Lake Helena are typically much larger than the resident trout, and facilitating passage at the diversion should allow spawning trout to reach additional spawning habitat above the dam while also producing a unique opportunity for anglers to catch trophy fish in a relatively small stream.

This project is close to an existing FWP Fishing Access Site, and unites other completed and ongoing habitat projects on Prickly Pear Creek in the Helena valley. This project will open up fish passage from Lake Helena to Montana City, and is a crucial piece in linking lower Prickly Pear to the Missouri River system.

Thank you for considering this application. Please feel free to contact me with any questions.

Sincerely,

Eric Roberts  
Helena Area Fish Biologist

## FUTURE FISHERIES IMPROVEMENT PROGRAM GRANT APPLICATION

Please fill in the highlighted areas  
all sections (IA, IB, IC, etc.) must be addressed or the application will be considered invalid

### I. APPLICANT INFORMATION

- A. Applicant Name: Eric Roberts
- B. Mailing Address: PO Box 200701
- C. City: Helena State: MT Zip: 59620
- Telephone: 406-495-3272 E-mail: eroberts@mt.gov
- D. Contact Person: Eric Roberts
- Address if different from Applicant:
- City:  State:  Zip:
- Telephone:  E-mail:
- E. Landowner and/or Lessee Name (if other than Applicant): Richard and Laurie Jo Tryan
- Mailing Address: 2225 Sierra Rd E
- City: Helena State: MT Zip: 59602
- Telephone: 406-439-1364 E-mail:

### II. PROJECT INFORMATION\*

- A. Project Name: Tryan Diversion fish passage
- River, stream, or lake: Prickly Pear Creek
- Location: Township: 10N Range: 3W Section: 9
- Latitude: 46.64273 Longitude: -111.98378 *within project (decimal degrees)*
- County: Lewis & Clark
- B. Purpose of Project:
- Construct in-stream step-pools and a fish bypass channel to facilitate fish passage around an existing diversion dam. Address excessive bank erosion above and below the diversion dam.
- C. Brief Project Description:

## Prickly Pear Creek Trynan fish passage

An existing diversion dam on Prickly Pear Creek in the Helena valley is a partial barrier to fish passage during non-irrigation season, and a full fish barrier during irrigation season when check boards are in place. This proposal is to construct step-pool structures in the stream to facilitate fish passage when the check boards are out, and construct a fish bypass channel around the diversion dam which would be activated when the dam check boards are in place. In-stream structures are expected to facilitate upstream passage of migratory rainbow trout in the spring, and the bypass channel is expected to allow upstream passage of migratory brown trout in the fall. Stream banks with excessive erosion upstream and downstream of the irrigation dam will be reconstructed and stabilized with wood debris and live plantings.

The project site is approximately 6 river miles above the confluence with Lake Helena. Large, migratory rainbow trout are commonly found below the diversion dam in the spring, with a few large fish able to negotiate the dam structure when flows are just right. There is no evidence of migratory brown trout passing the structure in the fall due to the height of the check board structure and/or inability to negotiate the dam structure after the boards are removed.

D. Length of stream or size of lake that will be treated: 1,025 feet

E. Project Budget:

Grant Request (Dollars): \$ 27,000

Contribution by Applicant (Dollars): \$ In-kind \$  
(salaries of government employees are not considered as matching contributions)

Contribution from other Sources (Dollars): \$ 91,592 In-kind \$  
(attach verification - See page 2 budget template)

**Total Project Cost: \$ 118,593**

F. Attach itemized (line item) budget – see template

G. Attach **specific project plans, detailed sketches, plan views, photographs, maps, evidence of landowner consent, evidence of public support and fish biologist support, and/or other information necessary to evaluate the merits of the project. If project involves water leasing or water salvage complete a *supplemental questionnaire*** (fwp.mt.gov/habitat/futurefisheries/supplement2.doc).

H. **Attach land management & maintenance plans that will ensure protection of the reclaimed area.**

### III. PROJECT BENEFITS\*

A. What species of fish will benefit from this project?:

Rainbow trout and brown trout.

B. How will the project protect or enhance wild fish habitat?:

## Prickly Pear Creek Trynan fish passage

The reach currently has a wild reproducing resident population of brown trout, but habitat is fragmented through most of the year due to blockage from the dam or flow conditions. In the spring (before irrigation season), migratory rainbow trout from Lake Helena are found above the diversion when flow conditions allow. The proposed project is expected to eliminate habitat fragmentation of resident brown trout within the stream reach, and facilitate upstream migration of spawning rainbow trout in the spring and brown trout in the fall.

In 2016, FWP population surveys in a reach approximately 1 mile above the project site found 405 brown trout per mile and 267 rainbow trout per mile. Over the past 6 years brown trout abundance has been steadily increasing, which is largely attributable to a re-watering project that has maintained flows through a reach of Prickly Pear Creek that historically went dry each summer. Rainbow trout abundance has been much more variable, due to inability to pass the irrigation structure in some years. Consistent fish passage at the diversion dam is expected to improve fish abundance in this monitoring section, as well as all of Prickly Pear across the Helena valley.

- C. Will the project improve fish populations and/or fishing? To what extent?:

Both rainbow trout and brown trout populations are expected to improve as migratory trout from Lake Helena will be able to access additional spawning habitat above the diversion dam.

- D. Will the project increase public fishing opportunity for wild fish and, if so, how?:

Improved fish populations are expected to increase public fishing opportunity. The Upper Prickly Pear Fishing Access Site is approximately 0.35 river miles upstream of the proposed project. The site is already popular for fishing for resident brown trout; presence of large migratory trout in Prickly Pear will provide a unique opportunity for anglers to catch trophy sized fish in a relatively small stream.

- E. The project agreement includes a 20-year maintenance commitment. Please discuss your ability to meet this commitment.

The landowners have partnered with FWP and other entities in the past to improve and maintain conservation efforts in the Prickly Pear riparian corridor. FWP staff will monitor the structure and work with the landowner to address any maintenance and operation issues with the structures.

- F. What was the cause of habitat degradation in the area of this project and how will the project correct the cause?:

The irrigation dam has fragmented habitat by blocking fish passage. Ponding of water above the dam and excessive velocities below the dam caused excessive streambank erosion. In-stream step-pool structures and the bypass channel should eliminate habitat fragmentation. Woody structures and vegetative plantings should reduce erosion rates and produce additional fish habitat.

- G. What public benefits will be realized from this project?:

Improved rainbow trout and brown trout abundance should improve fishing opportunity. The opportunity to catch trophy sized fish in a relatively small stream also provides a unique fishing option.

- H. Will the project interfere with water or property rights of adjacent landowners? (explain):

The Trynans have the only water right on the irrigation dam. Conveyance of water to their headgate is the top priority, and the proposed construction is not expected to impact delivery of irrigation water. The project site is on a remote pasture on the Ludke property, and is not expected to impact current land practices on their property.

Prickly Pear Creek Trynan fish passage

- I. Will the project result in the development of commercial recreational use on the site?: (explain):

No. Public use of Prickly Pear Creek by anglers may increase with increased fish abundance, but development of commercial recreational use is not expected.

- J. Is this project associated with the reclamation of past mining activity?:

No.

**Each approved project applicant must enter into a written agreement with Montana Fish, Wildlife & Parks specifying terms and duration of the project. The applicant must obtain all applicable permits prior to project construction. A competitive bid process must be followed when using State funds.**

**IV. AUTHORIZING STATEMENT**

I (we) hereby declare that the information and all statements to this application are true, complete, and accurate to the best of my (our) knowledge and that the project or activity complies with rules of the Future Fisheries Improvement Program.

Applicant Signature: \_\_\_\_\_

Date: \_\_\_\_\_

11/29/2017

Sponsor (if applicable): \_\_\_\_\_

**\*Highlighted boxes will automatically expand.**

**Mail To:** Montana Fish, Wildlife & Parks  
Fisheries Division  
PO Box 200701  
Helena, MT 59620-0701

**E-mail To:** Michelle McGree  
[mmcgree@mt.gov](mailto:mmcgree@mt.gov)  
(electronic submissions **MUST** be signed)

Incomplete or late applications will be rejected and returned to applicant.  
Applications may be rejected if this form is modified.

**\*\*\*Applications must be signed and *received* by the Future Fisheries Program Officer in Helena before December 1 and June 1 of each year to be considered for the subsequent funding period.\*\*\***

Prickly Pear Creek Trynan fish passage  
**BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS**

Both tables must be completed or the application will be returned

WORK ITEMS (ITEMIZE BY CATEGORY)	NUMBER OF UNITS	UNIT DESCRIPTION*	COST/UNIT	TOTAL COST	CONTRIBUTIONS			
					FUTURE FISHERIES REQUEST	IN-KIND SERVICES**	IN-KIND CASH	TOTAL
<b>Personnel***</b>								
Survey				\$ -				\$ -
Design				\$ -				\$ -
Engineering				\$ -				\$ -
Permitting	1		\$10,000.00	\$ 10,000.00			10,000.00	\$ 10,000.00
Oversight	1		\$6,000.00	\$ 6,000.00			6,000.00	\$ 6,000.00
				\$ -				\$ -
			Sub-Total	\$ 16,000.00	\$ -	\$ -	\$ 16,000.00	\$ 16,000.00
<b>Travel</b>								
Mileage				\$ -				\$ -
Per diem	42	days	\$75.00	\$ 3,150.00			3,150.00	\$ 3,150.00
			Sub-Total	\$ 3,150.00	\$ -	\$ -	\$ 3,150.00	\$ 3,150.00
<b>Construction Materials****</b>								
Category 1 rock (36-48")	125	ea	\$51.84	\$ 6,480.00	6,480.00			\$ 6,480.00
Category 2 rock (24-30")	138	ea	\$26.09	\$ 3,600.42	3,600.42			\$ 3,600.42
Streambed/ bank fill	235	cy	\$72.00	\$ 16,920.00	16,920.00			\$ 16,920.00
Wood	5358	ea	\$1.50	\$ 8,037.00			8,037.00	\$ 8,037.00
5' slide gate	1	ea	\$4,800.00	\$ 4,800.00			4,800.00	\$ 4,800.00
24" cmp	1	ea	\$840.00	\$ 840.00			840.00	\$ 840.00
8 oz geotextile	259	lf	\$3.09	\$ 800.31			800.31	\$ 800.31
			Sub-Total	\$ 41,477.73	\$ 27,000.42	\$ -	\$ 14,477.31	\$ 41,477.73
<b>Equipment and Labor</b>								
Cat 325 Excavator	106	hr	\$165.00	\$ 17,490.00			17,490.00	\$ 17,490.00
Cat 320 Excavator	107	hr	\$145.00	\$ 15,515.00			15,515.00	\$ 15,515.00
Cat 229	82	hr	\$95.00	\$ 7,790.00			7,790.00	\$ 7,790.00
CD 110 ASV	62	hr	\$135.00	\$ 8,370.00			8,370.00	\$ 8,370.00
GPS base/ receiver	14	hr	\$250.00	\$ 3,500.00			3,500.00	\$ 3,500.00
			Sub-Total	\$ 52,665.00	\$ -	\$ -	\$ 52,665.00	\$ 52,665.00
<b>Mobilization</b>								
Mobilization	1	ea	\$5,300.00	\$ 5,300.00			5,300.00	\$ 5,300.00
			Sub-Total	\$ 5,300.00	\$ -	\$ -	\$ 5,300.00	\$ 5,300.00
<b>TOTALS</b>				\$ 118,592.73	\$ 27,000.42	\$ -	\$ 91,592.31	\$ 118,592.73

Prickly Pear Creek Trynna fish passage  
BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS

**OTHER REQUIREMENTS:**

**All of the columns in the budget table and the matching contribution table MUST be completed appropriately or the application will be invalid.** Please see the example budget sheet for additional clarification.

\*Units = feet, hours, inches, etc. Do not use lump sum unless there is no other way to describe the costs.

\*\*Can include in-kind materials. Justification for in-kind labor (e.g. hourly rates used for calculations). Describe here or in text.

Reminder: Government salaries cannot be used as in-kind match

\*\*\*The Review Panel suggests that design and oversight costs associated with a proposed project not exceed 15% of the total project budget. If design and oversight costs are in excess of 15%, applications must include a minimum of two competitive bids for the cost of undertaking the project.

\*\*\*\*The Review Panel recommends a maximum fencing cost of \$1.50 per foot. Additional costs may be the responsibility of the applicant and/or partners.

**MATCHING CONTRIBUTIONS** (do not include requested funds)

CONTRIBUTOR	IN-KIND SERVICE	IN-KIND CASH	TOTAL	Secured? (Y/N)
NWE MoTAC (FERC license requirements)	\$ -	\$ 91,592.31	\$ 91,592.31	Y
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
	\$ -	\$ -	\$ -	
<b>TOTALS</b>	\$ -	\$ 91,592.31	\$ 91,592.31	





Figure 1: Photo of the Tryan diversion dam.



Figure 2: Looking upstream from the Tryan diversion dam. Photo taken when check boards in place.



### Prickly Pear Creek Trynan fish passage



Figure 3: Looking downstream from the Trynan diversion dam.



Figure 4: View of the diversion dam during spring flows, with boards removed.

## Prickly Pear Creek Trynan fish passage



Figure 5: View downstream of the diversion dam during spring flows. Note heavily eroded bank on the outside bend.



FINAL DESIGN

TRYAN IRRIGATION DIVERSION FISH PASSAGE PROJECT

PRICKLY PEAR CREEK

NEAR HELENA, MONTANA

PROJECT PARTNERS

**NorthWestern Energy**

NORTHWESTERN ENERGY, INC.  
6700 RAINBOW DAM ROAD  
GREAT FALLS, MT 59404

**Montana Fish, Wildlife & Parks**

MONTANA FISH, WILDLIFE & PARKS  
P.O. BOX 200701  
HELENA, MT 59620

PROJECT DESCRIPTION

LOCATED NEAR HELENA, MONTANA, PRICKLY PEAR CREEK RUNS SOUTH TO NORTH DRAINING INTO LAKE HELENA. THE PROJECT AREA SUPPLIES THE TRYAN DIVERSION, AND CONSISTS OF DIVERSION AND FISH PASSAGE INFRASTRUCTURE THAT CURRENTLY IMPEDES UPSTREAM FISH MIGRATION. THE DIVERSION IS A PARTIAL FISH BARRIER, ALLOWING SOME ADULT FISH PASSAGE WHEN THE CHECK BOARDS ARE REMOVED OUTSIDE OF THE IRRIGATION SEASON. ADULT MIGRATORY RAINBOW TROUT ARE FOUND UPSTREAM OF THE DIVERSION IN THE SPRING, BUT THE DIVERSION IS LIKELY A VELOCITY BARRIER TO JUVENILE SALMONIDS EVEN WHEN THE CHECK BOARDS ARE OUT. LOW FLOWS IN THE FALL AND HIGH WATER VELOCITIES OVER THE STRUCTURE LIKELY PREVENT PASSAGE OF FALL SPAWNING SALMONIDS AS WELL. NORTHWESTERN ENERGY HAS CONTRACTED WITH RIVER DESIGN GROUP, INC (R.D.G.), TO PREPARE AN ENGINEERED DESIGN THAT WILL IMPROVE FISH PASSAGE AND ELIMINATE ENTRAINMENT OF ALL FISH SPECIES ASSOCIATED WITH THE DIVERSION STRUCTURE.

SPECIFIC OBJECTIVES OF THIS PROJECT INCLUDE:

- PROVIDE YEAR LONG PASSAGE FOR ALL SALMONIDS;
- INSTALL MAIN CHANNEL BOULDER STEP POOL STRUCTURES TO ALLOW FISH PASSAGE WHEN THE DIVERSION STRUCTURE IS NOT IN USE.
- PROVIDE UPSTREAM FISH PASSAGE AT ALL FLOW LEVELS BY IMPLEMENTING A FISH BYPASS CHANNEL CAPABLE OF PASSING SALMONIDS FOR MULTIPLE LIFE STAGES;
- ADDRESS EXCESSIVE STREAM BANK EROSION UPSTREAM AND DOWNSTREAM OF THE DIVERSION PROJECT THAT HAS BEEN AFFECTED BY THE EXISTING DIVERSION INFRASTRUCTURE.

THIS PLAN SET REPRESENTS A CONCEPTUAL DESIGN.

BENCHMARK

SURVEY CONTROL WAS ESTABLISHED UNDER THE RESPONSIBLE CHARGE OF ANDREW BELSKI, PLS 14731.

THE PROJECT COORDINATES ARE BASED ON THE FOLLOWING:

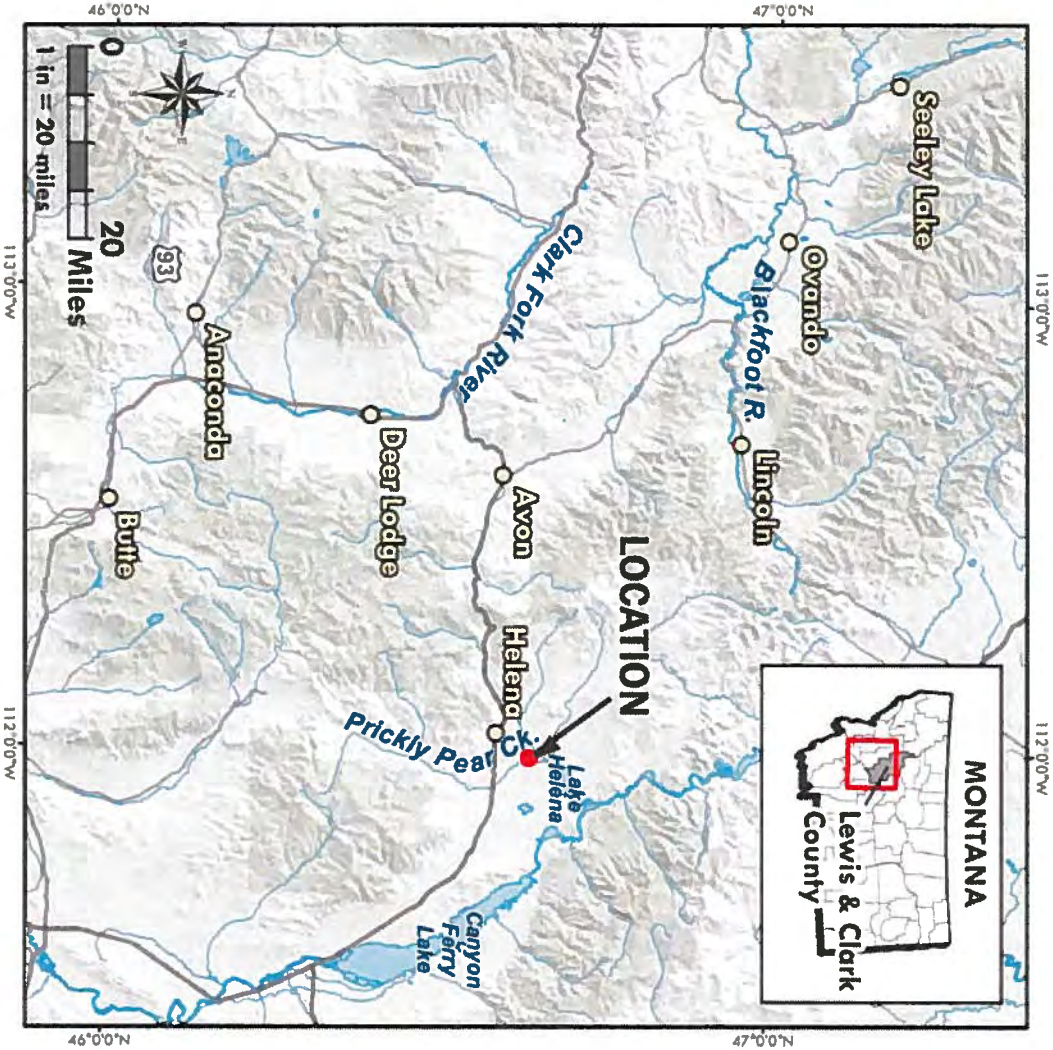
HORIZONTAL PROJECTION: MT83F

HORIZONTAL DATUM: NAD83 CORS 2011

UNITS: US SURVEY FEET

VERTICAL DATUM: NAVD88 (GEOID 12A)

PROJECT VICINITY MAP



DRAWING INDEX

- CP-1 COVER PAGE AND NOTES
- SP-1 SITE PLAN
- PV-1 PLAN VIEW
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- DT-1 SLIDE GATE DETAIL
- DT-2 ROCK STEP AND ROUGHENED RIFLE DETAIL
- DT-3 BOULDER STEP POOL DETAIL
- DT-4 VEGETATED WOOD MATRIX DETAIL
- DT-5 LARGE WOOD STRUCTURE DETAIL
- MT-1 MATERIALS LIST

COVER PAGE AND NOTES

**RDG**  
RIVER DESIGN GROUP

236 Wisconsin Avenue  
Whitefish, MT 59937  
tel: 406.862.4927  
fax: 406-862-4963

311 SW Jefferson Avenue  
Corvallis, OR 97333  
tel: 541.738.2920  
fax: 541.758.8524

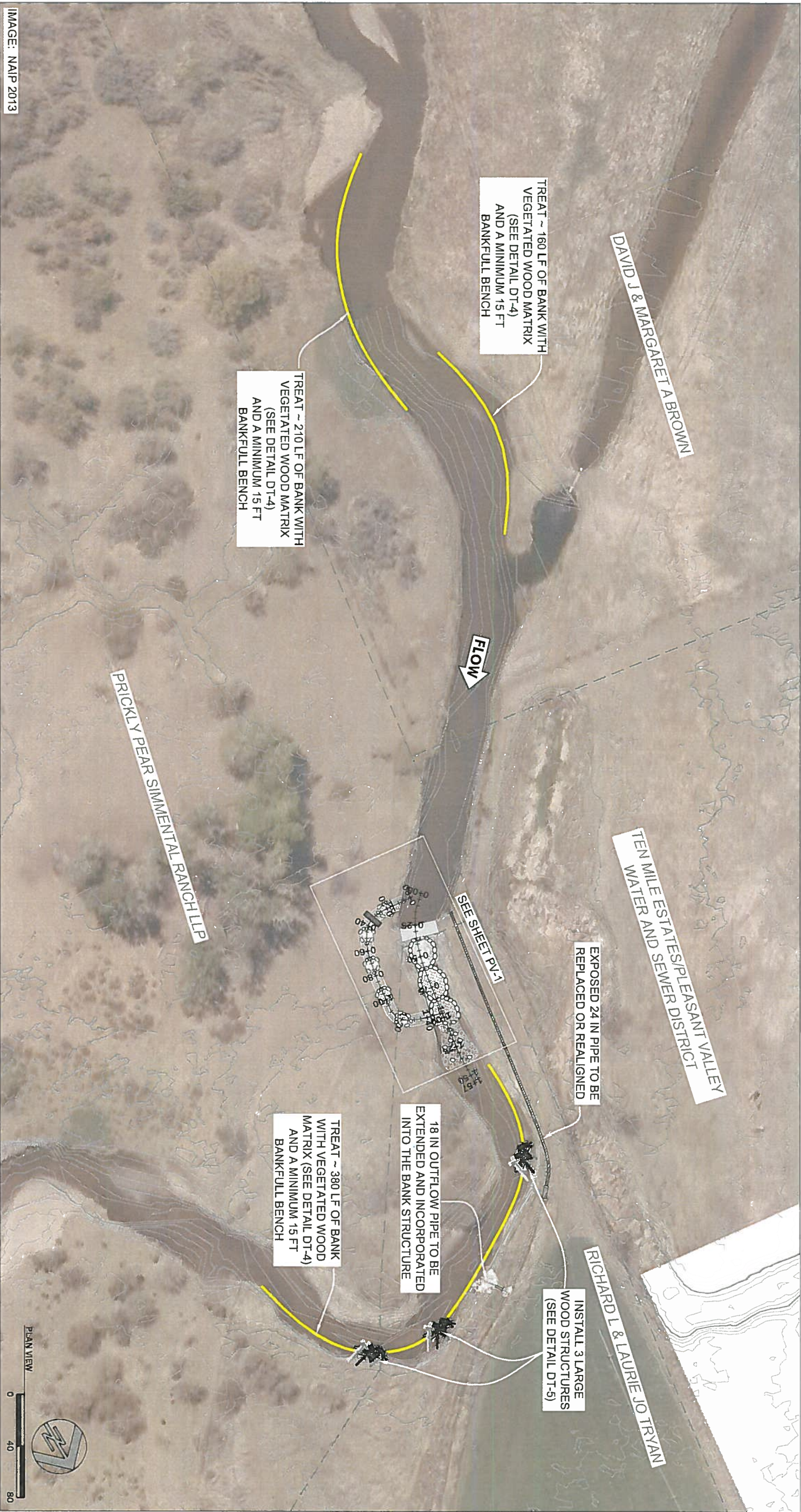
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2	9-26-17	NW	FINAL DESIGN	GD

PROJECT NUMBER  
RDG-17-033

SHEET NUMBER

CP-1





NO.	DATE	BY	DESCRIPTION	CHK
1	7-6-17	NW	PRELIMINARY DESIGN	GD
2	9-26-17	NW	FINAL DESIGN	GD

RDG  
RIVER DESIGN GROUP

236 Wisconsin Avenue  
Whitefish, MT 59937  
tel: 406.862.4927  
fax: 406-862-4963

311 SW Jefferson Avenue  
Corvallis, OR 97333  
tel: 541.738.2920  
fax: 541.758.8524

SP-1

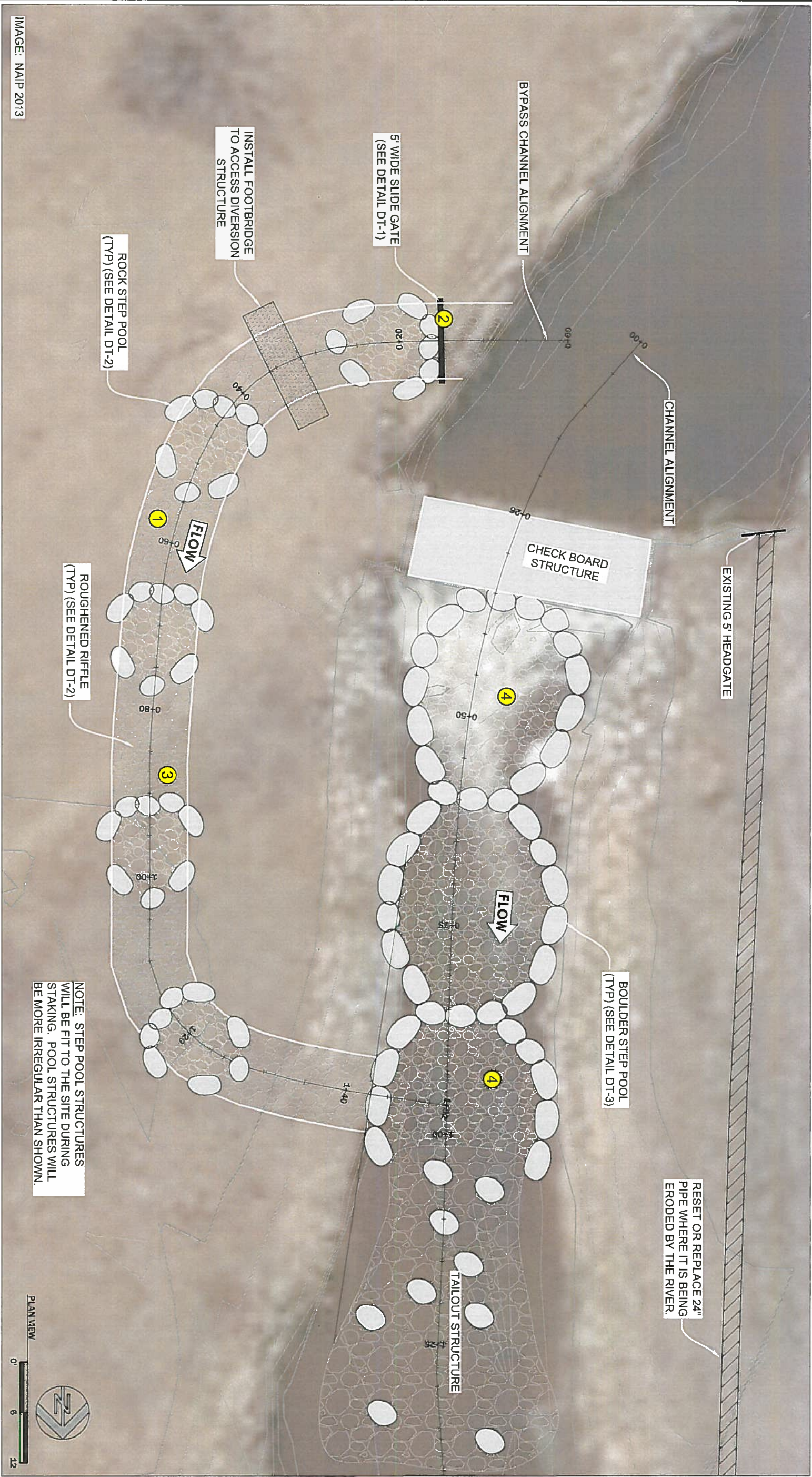
SHEET NUMBER

PROJECT NUMBER  
RDG-17-033

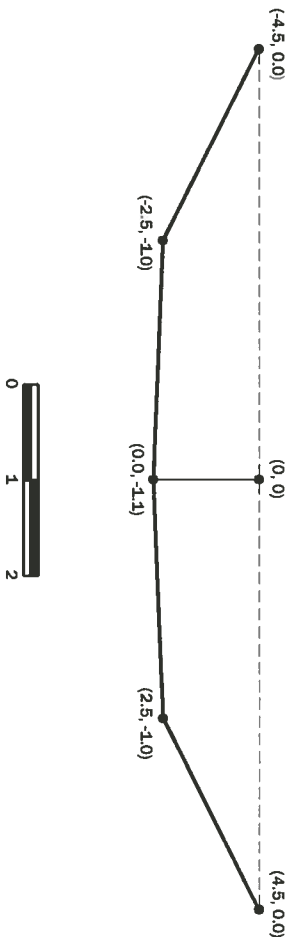
SITE PLAN

RDG  
RIVER DESIGN GROUP





TYPICAL BYPASS CHANNEL RIFFLE CROSS SECTION



CONSTRUCTION NOTES

- 1 BYPASS CHANNEL TO SUPPORT SALMONID PASSAGE WHEN DIVERSION CHECK BOARDS ARE IN USE. BYPASS CHANNEL NOT ACTIVE WHEN CHECK BOARDS ARE NOT IN USE.
- 2 60" SLIDE GATE ENTRANCE.
- 3 BYPASS CHANNEL FLOW RANGE = 3-15 CFS.
- 4 MAIN CHANNEL STEP POOLS TO PROVIDE SALMONID PASSAGE DURING NON-IRRIGATION SEASON.

PLAN VIEW



236 Wisconsin Avenue  
Whitefish, MT 59937  
tel: 406.862.4927  
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311 SW Jefferson Avenue  
Corvallis, OR 97333  
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fax: 541.758.8524

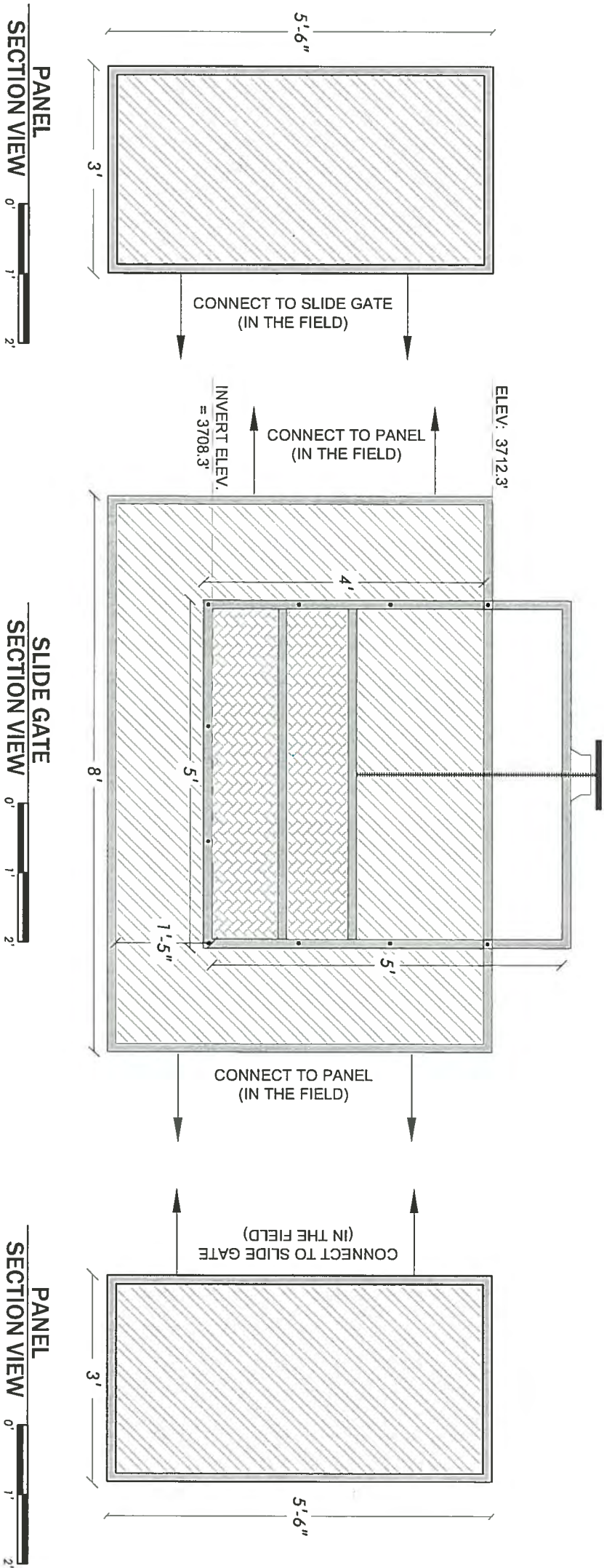
NO.	DATE	BY	DESCRIPTION	CHK
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2	9-26-17	NW	FINAL DESIGN	GD



	NO.	DATE	BY	DESCRIPTION	CHK
	1	7-6-17	NW	PRELIMINARY DESIGN	GD
	2	9-26-17	NW	FINAL DESIGN	GD

# PROFILE VIEWS

River Design Group  
 236 Wisconsin Avenue Whitefish, MT 59937      tel: 406.862.4927 fax: 406.862.4963  
 311 SW Jefferson Avenue Corvallis, OR 97333      tel: 541.738.2920 fax: 541.758.8524



 1/2" PLATE STEEL  
(NO BENDS)

 INTAKE SLIDE GATE  
A 200 GRADE  
ALUMINUM

SLIDE GATE DETAIL



**RDG**  
RIVER DESIGN GROUP

236 Wisconsin Avenue  
Whitefish, MT 59937  
tel: 406.862.4927  
fax: 406-862-4963

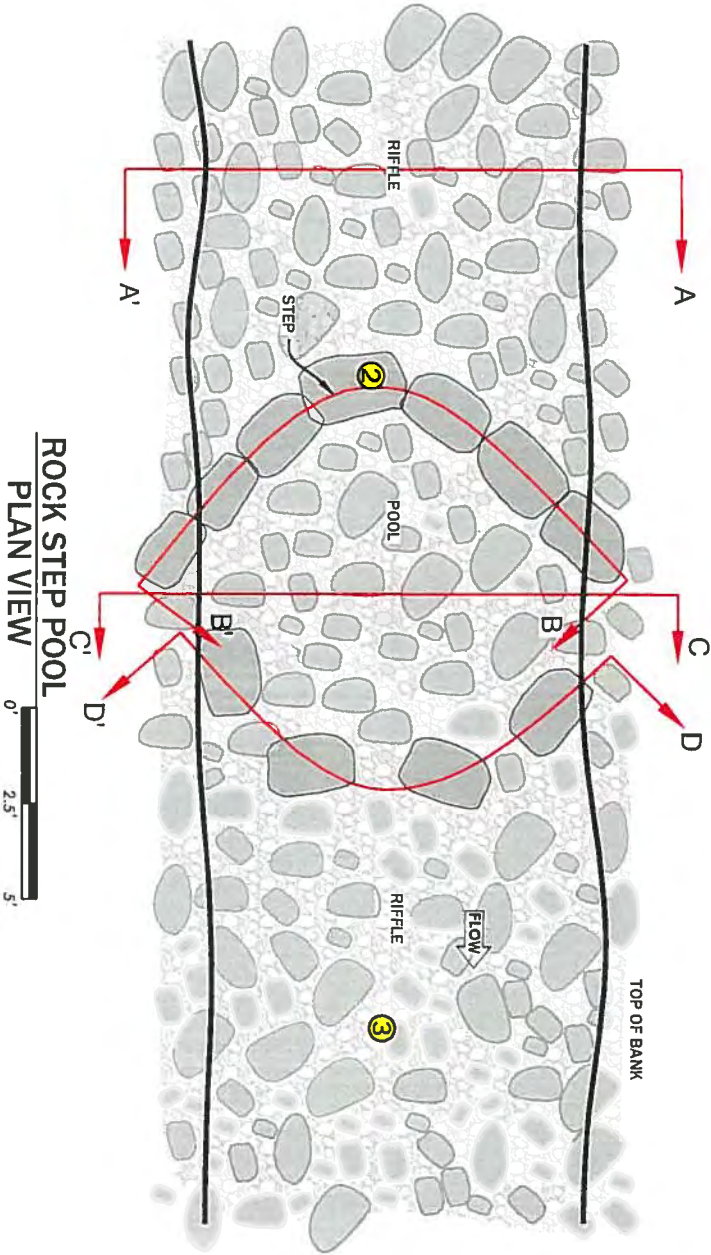
311 SW Jefferson Avenue  
Corvallis, OR 97333  
tel: 541.738.2920  
fax: 541.758.8524

NO.	DATE	BY	DESCRIPTION	CHK
1	9-26-17	NW	FINAL DESIGN	GD

PROJECT NUMBER  
RDG-17-033

SHEET NUMBER

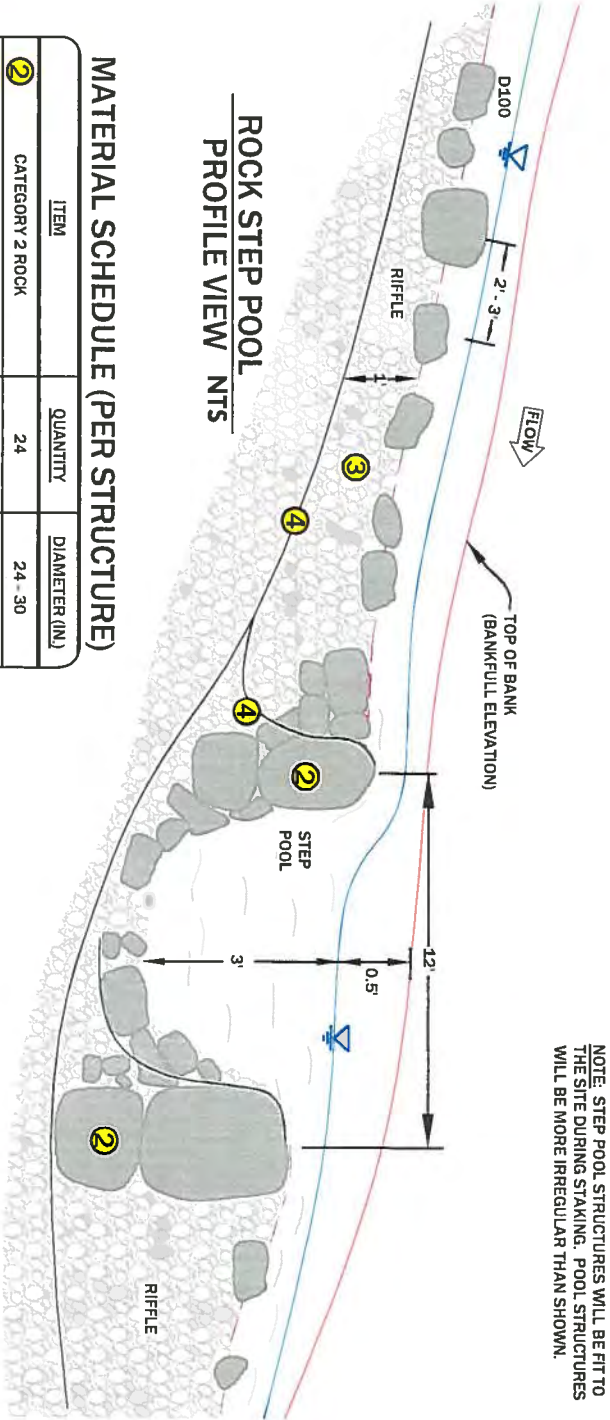




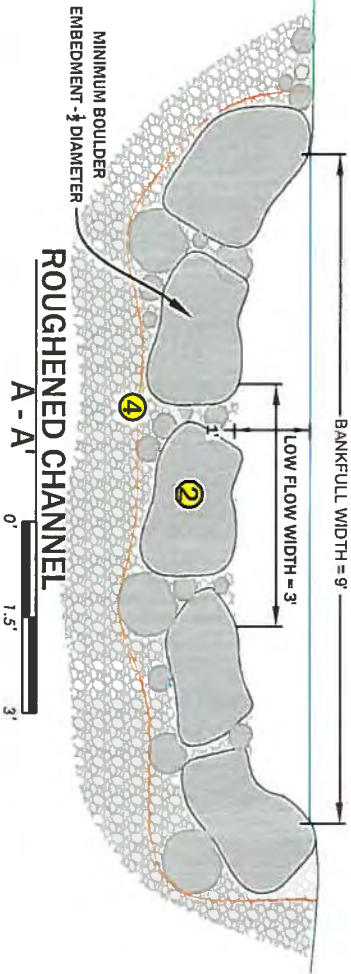
ROCK STEP POOL  
PLAN VIEW

MATERIAL SCHEDULE (PER STRUCTURE)			
ITEM	QUANTITY	DIAMETER (IN.)	
2	24	24 - 30	
3	9 CY	SEE GRADATION	
4	250 SF	8MM THICKNESS	

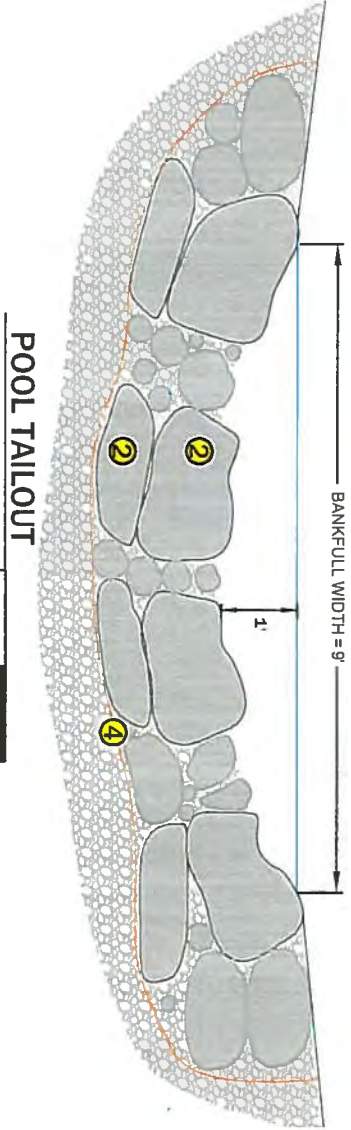
ROCK STEP POOL  
PROFILE VIEW NTS



NOTE: STEP POOL STRUCTURES WILL BE FIT TO THE SITE DURING STAKING. POOL STRUCTURES WILL BE MORE IRREGULAR THAN SHOWN.



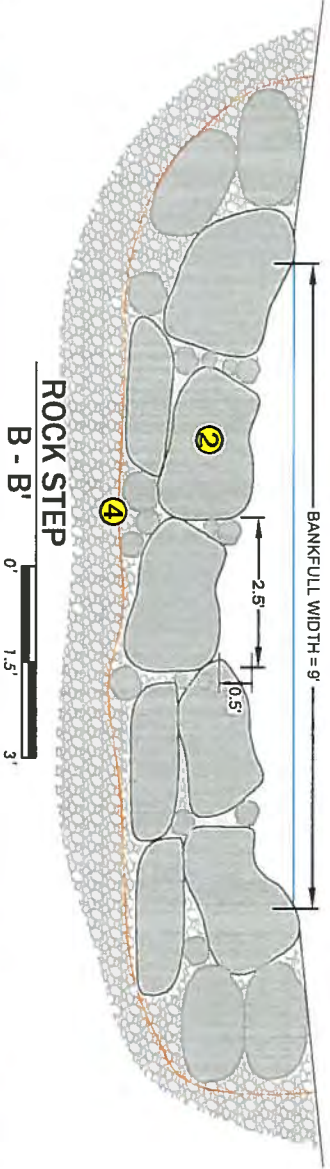
ROUGHENED CHANNEL  
A - A'



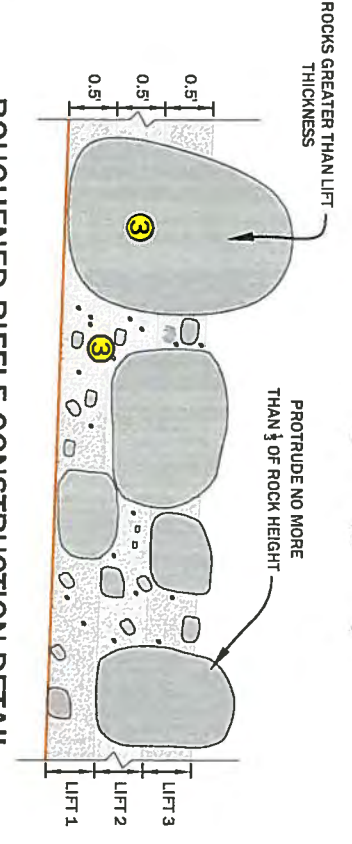
POOL TAILOUT  
D - D'

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
10	95	D100
8	90-95	D95
6	85-90	D84
5	65 - 85	D65
4	50 - 65	D50
2	35 - 50	D35
1	20 - 35	D15
FINES	20	

STREAMBED FILL GRADATION



ROCK STEP  
B - B'



ROUGHENED RIFFLE CONSTRUCTION DETAIL  
D - D'

NOTES ON BOULDER STEP POOL STRUCTURE

GENERAL NOTES

1. THE INTENT OF THE STEP POOL AND ROUGHENED RIFFLE STRUCTURE IS TO PROVIDE VERTICAL AND LATERAL STABILITY FOR STREAM TYPES EXHIBITING LOW SINUOSITY AND STEEP GRADIENTS. THE STRUCTURE CONSISTS OF ALTERNATING GRADE CONTROL STEPS AND PLUNGE POOLS. VELOCITY AND ENERGY DISSIPATION IS CONTROLLED BY STEP SPACING WHICH IS DETERMINED AS A FUNCTION OF GRADIENT RELATIVE TO CHANNEL WIDTH. STEP HEIGHT IS DESIGNED TO MAINTAIN UPSTREAM FISH PASSAGE AT ALL FLOW LEVELS. PLUNGE POOLS PROVIDE RESTING AREAS FOR FISH TO STAGE.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATIONS FOR EACH STEP POOL STRUCTURE PRIOR TO CONSTRUCTION.

1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN ON THE DRAWING OR AS MARKED IN THE FIELD BY ENGINEER. EXCAVATED MATERIALS SHALL BE REMOVED FROM THE FLOODPLAIN.
2. PREPARE THE SUBGRADE OF THE EXCAVATION BY PLACING AND BUCKET COMPACTING CHANNEL ALLUVIUM TO THE ELEVATIONS SHOWN ON THE DRAWINGS OR AS DIRECTED BY ENGINEER.
3. PLACE NON-WOVEN FABRIC THROUGH THE ROUGHENED RIFFLE AT SUBGRADE DEPTH AS SHOWN ON THE DRAWINGS. PLACE D100 FRAMEWORK ROCK AS SHOWN ON CONSTRUCTION DETAIL. PLACE REMAINING STREAMBED MATERIAL IN SIX INCH LIFTS AND COMPACT USING EQUIPMENT BUCKET. WASH FINES INTO RIFFLE STREAMBED GRADATION TO FILL VOIDS AND SEAL RIFFLE BED.
4. STEP POOLS SHALL BE CONSTRUCTED FROM ROCKS WITH THE DIMENSIONS SHOWN IN THE MATERIAL SCHEDULE. ROCK SHALL BE FROM AN APPROVED SOURCE AND SHALL BE SOUND, DENSE (SG=2.65 MIN.) AND FREE FROM CRACKS, SEAMS OR OTHER DEFECTS THAT CAN ACCELERATE WEATHERING.
5. PLACE ROCKS ACCORDING TO THE LAYOUT AND ELEVATIONS SHOWN ON DRAWINGS PV-1 AND PE-1 OR AS DIRECTED BY FIELD ENGINEER. FOOTER ROCKS SHALL BE PLACED UNDER ALL CAP ROCKS UNLESS CAP ROCKS EXTEND GREATER THAN FOUR FEET BELOW TOP OF BANK ELEVATION. ALL ROCKS SHALL BE PLACED ON SUITABLE SUBGRADE CONSISTING OF COARSE ALLUVIUM AS APPROVED BY ENGINEER. ROCK SHALL BE EQUIPMENT-PLACED SO THAT LARGER ROCKS ARE UNIFORMLY DISTRIBUTED WITH NO GAPS BETWEEN BOTH FOOTER ROCKS AND CAP ROCKS. ALLUVIUM SHALL BE PLACED IN VOIDS BETWEEN FOOTER ROCKS AND CAP ROCKS.
6. PLACE NON-WOVEN GEOTEXTILE FABRIC ON THE UPSTREAM SIDE OF STEP POOLS TO MINIMIZE PILING OF WATER THROUGH THE STEPS. FABRIC SHALL BE PLACED ACROSS THE ENTIRE WIDTH OF THE STEP THROAT AND SHALL EXTEND BELOW THE ESTIMATED SCOUR DEPTH AS SHOWN ON THE DRAWINGS AND AS DIRECTED BY ENGINEER. BACKFILL FABRIC WITH ALLUVIUM AND ROCK AS SHOWN ON THE DRAWINGS.

ROCK STEP POOL AND  
ROUGHENED RIFFLE DETAIL



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NO.	DATE	BY	DESCRIPTION	CHK
1	7-26-17	NW	PRELIMINARY DESIGN	GD
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DT-2

PROJECT NUMBER  
RDG-17-033

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GENERAL NOTES

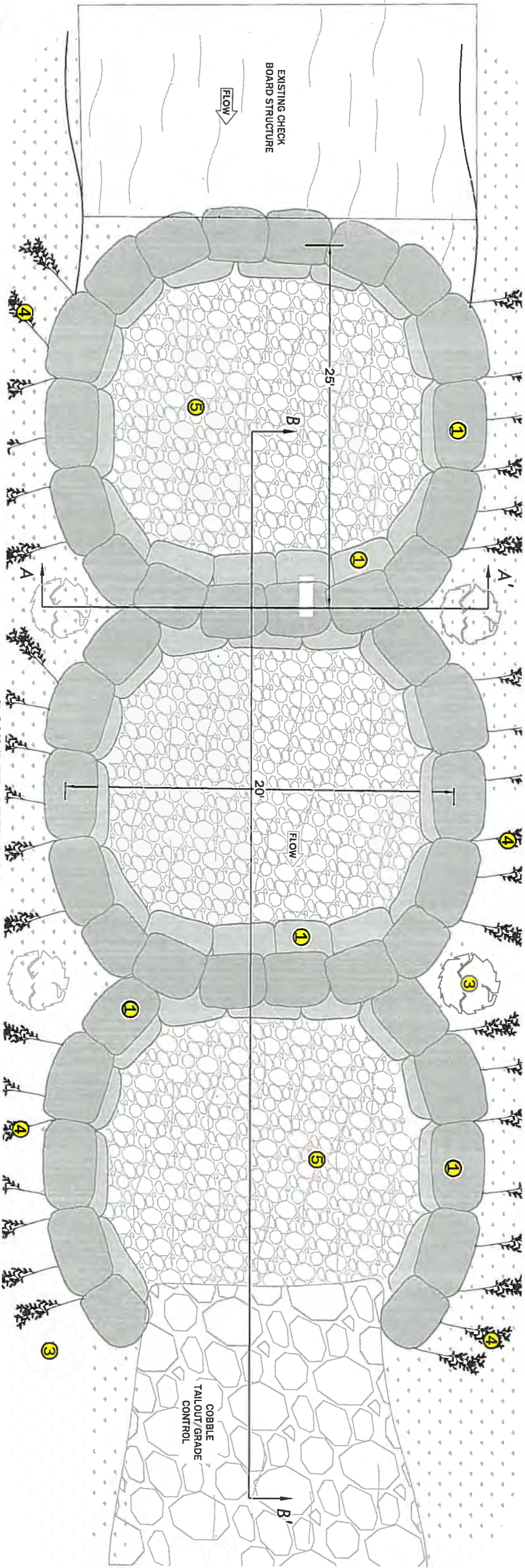
1. THE INTENT OF THE BOULDER STEP POOL STRUCTURE IS TO PROVIDE VERTICAL AND LATERAL STABILITY FOR ENRICHED STREAM TYPES EXHIBITING STEEP GRADIENTS. THE STRUCTURE CONSISTS OF ALTERNATING GRADE CONTROL STEPS AND PLUNGE POOLS. VELOCITY AND ENERGY DISSIPATION IS CONTROLLED BY STEP SPACING WHICH IS DETERMINED AS A FUNCTION OF GRADIENT RELATIVE TO CHANNEL WIDTH. STEP HEIGHT IS DESIGNED TO MAINTAIN UPSTREAM FISH PASSAGE AT ALL FLOW LEVELS. PLUNGE POOLS PROVIDE RESTING AREAS FOR FISH TO STAGE.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATIONS FOR EACH BOULDER STEP POOL STRUCTURE PRIOR TO CONSTRUCTION.

NOTES ON BOULDER STEP POOL STRUCTURE

1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN ON THE DRAWING OR AS MARKED IN THE FIELD BY ENGINEER. EXCAVATED MATERIALS SHALL BE REMOVED FROM THE FLOODPLAIN.
2. PREPARE THE BASE OF THE EXCAVATION BY PLACING AND BUCKET COMPACTING CHANNEL ALLUVIUM TO THE ELEVATIONS SHOWN ON THE DRAWINGS OR AS DIRECTED BY ENGINEER.
3. STEP POOLS SHALL BE CONSTRUCTED FROM ROCKS WITH THE DIMENSIONS SHOWN IN THE MATERIAL SCHEDULE. ROCK SHALL BE FROM AN APPROVED SOURCE AND SHALL BE SOUND, DENSE (SG=2.65 MIN.) AND FREE FROM CRACKS, SEAMS OR OTHER DEFECTS THAT CAN ACCELERATE WEATHERING.
4. PLACE ROCKS ACCORDING TO THE LAYOUT AND ELEVATIONS SHOWN ON DRAWINGS PV-1 AND PF-1 OR AS DIRECTED BY FIELD ENGINEER. FOOTER ROCKS SHALL BE PLACED UNDER ALL CAP ROCKS UNLESS CAP ROCKS EXTEND GREATER THAN FIVE FEET BELOW TOP OF BANK ELEVATION. ALL ROCKS SHALL BE PLACED ON SUITABLE SUBGRADE CONSISTING OF COARSE ALLUVIUM AS APPROVED BY ENGINEER. ROCK SHALL BE EQUIPMENT-PLACED SO THAT LARGER ROCKS ARE UNIFORMLY DISTRIBUTED WITH NO GAPS BETWEEN BOTH FOOTER ROCKS AND CAP ROCKS. PLACE RIPARIAN CUTTINGS AT A RATE OF 3 PER FOOT ON THE OUTSIDE BANK OF THE STEP POOL. BOULDERS, ALLUVIUM AND BACKFILL SHALL BE PLACED IN VOIDS AROUND RIPARIAN CUTTINGS AND BETWEEN FOOTER ROCKS AND CAP ROCKS.
5. PLACE NON WOVEN GEOTEXTILE FABRIC ON THE UPSTREAM SIDE OF STEP POOLS TO MINIMIZE PIPING OF WATER THROUGH THE STEPS. FABRIC SHALL BE PLACED ACROSS THE ENTIRE WIDTH OF THE STEP THROAT AND SHALL EXTEND BELOW THE ESTIMATED SCOUR DEPTH AS SHOWN ON THE DRAWINGS AND AS DIRECTED BY ENGINEER. BACKFILL FABRIC WITH ALLUVIUM AND ROCK AS SHOWN ON THE DRAWINGS.
6. THE UPSTREAM TIE-IN AND DOWNSTREAM TAILOUT/ GRADE CONTROL STRUCTURE SHALL TRANSITION SMOOTHLY INTO EXISTING FEATURES AS DIRECTED BY ENGINEER. STRUCTURE TIE-IN LOCATIONS MAY BE STABILIZED WITH ADDITIONAL ALLUVIUM AS DIRECTED BY ENGINEER.

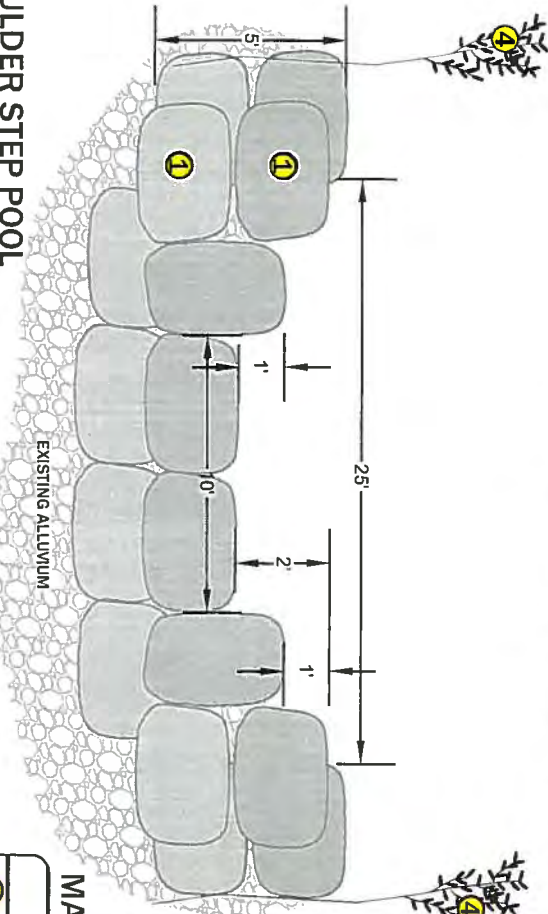
STREAMBED FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
10	95	D100
8	90-95	D95
6	85-90	D84
5	65 - 85	D65
4	50 - 65	D50
2	35 - 50	D35
1	20 - 35	D15
FINES	20	



BOULDER STEP POOL  
NTS

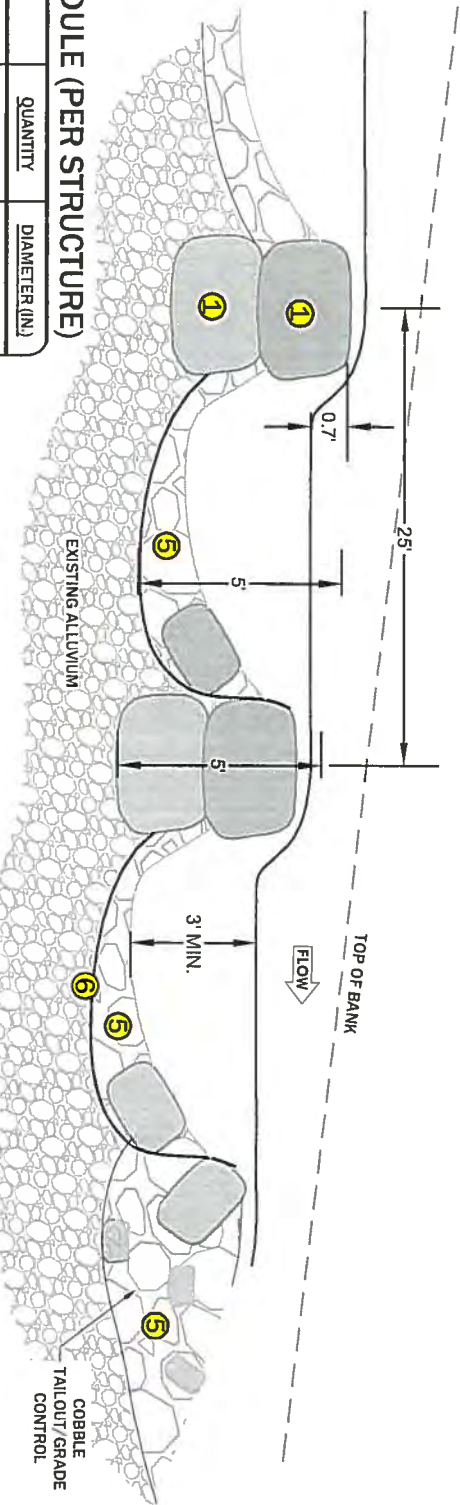
NOTE: STEP POOL STRUCTURES WILL BE FIT TO THE SITE DURING STAKING. POOL STRUCTURES WILL BE MORE IRREGULAR THAN SHOWN.



BOULDER STEP POOL  
A - A'  
NTS

MATERIAL SCHEDULE (PER STRUCTURE)

ITEM	QUANTITY	DIAMETER (IN.)
1 CATEGORY 1 ROCK	50	36 - 48
3 TRANSPLANTS	2	3 - 6
4 RIPARIAN CUTTINGS	3	0.25
5 STREAMBED FILL	14 CY	SEE GRADATION
6 NON-WOVEN GEOTEXTILE FABRIC	30 FT	8MM THICKNESS



BOULDER STEP POOL  
B - B'  
NTS

BOULDER STEP POOL DETAIL

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1	7-26-17	NW	PRELIMINARY DESIGN	GD
2	9-26-17	NW	FINAL DESIGN	GD

PROJECT NUMBER  
RDG-17-033

SHEET NUMBER

DT-3

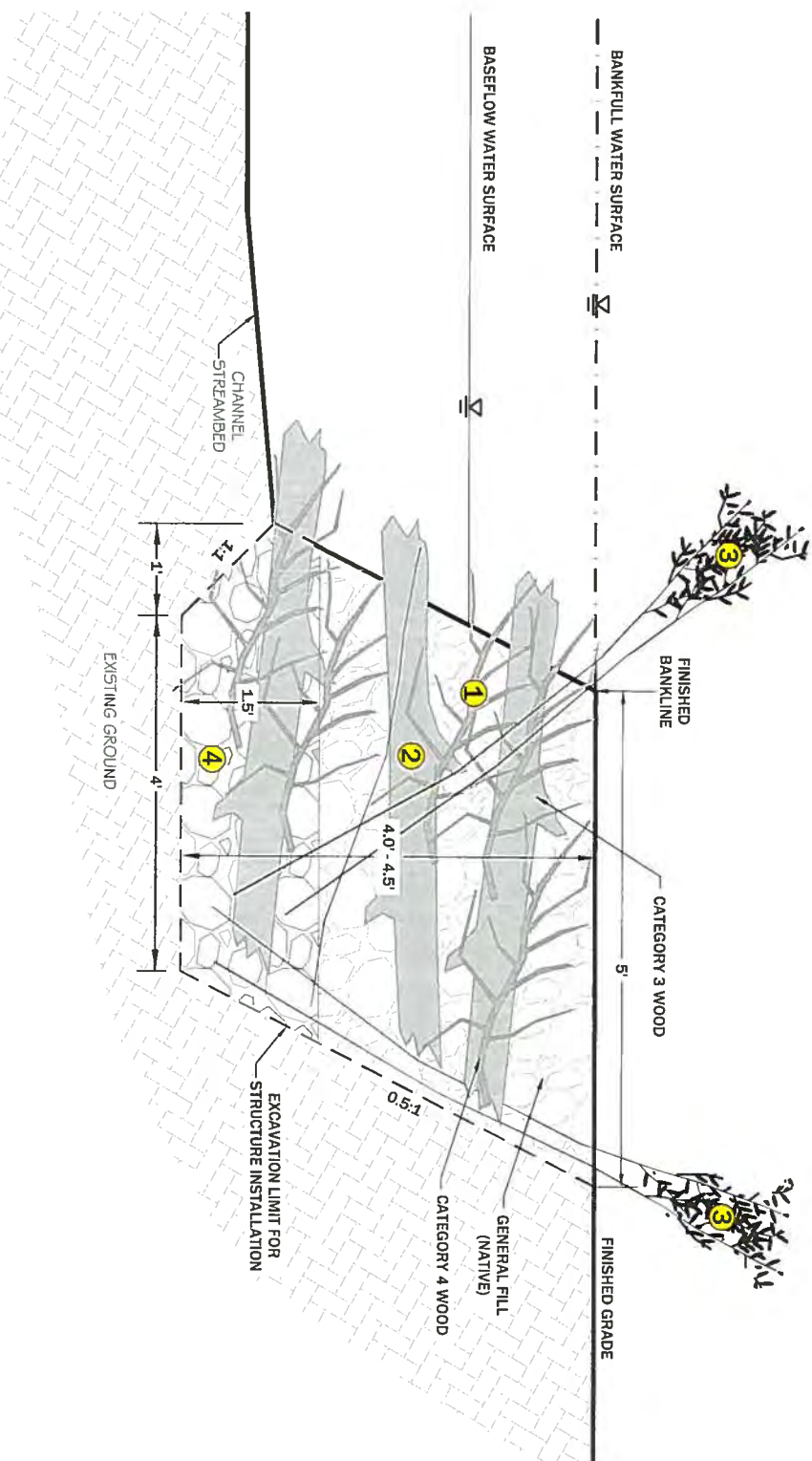


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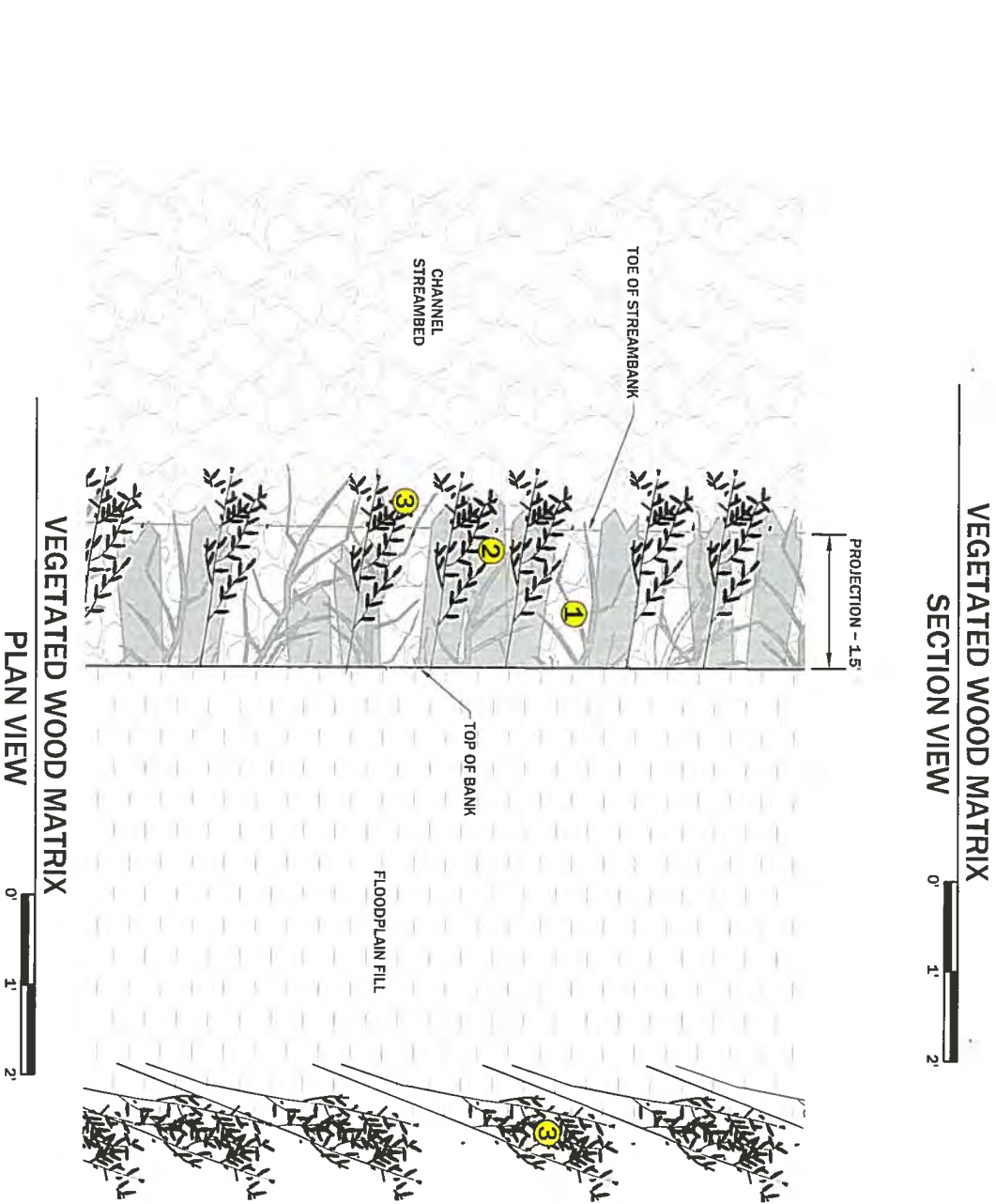


## GENERAL NOTES

1. CONSTRUCTION OF THE VEGETATED WOOD MATRIX WILL OCCUR ALONG THE BANK MARGINS NOTED ON SHEET PV-2 OR AS DIRECTED BY CONSTRUCTION SUPERVISOR.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH VEGETATED WOOD MATRIX STRUCTURE PRIOR TO CONSTRUCTION

## NOTES ON VEGETATED WOOD AND BRUSH FASCINE INSTALLATION

1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. PREPARE THE BASE OF THE STRUCTURE BY PLACING CHANNEL ALLUVIUM FROM THE BASE OF THE EXCAVATION DEPTH/BOTTOM OF EXCAVATION TO WITHIN 1.0-FT. OF FINISHED GRADE.
3. CATEGORY 2 AND CATEGORY 3 WOOD, CHANNEL ALLUVIUM, AND (6) TO EIGHT (8) FT. DORMANT WILLOW CUTTINGS AT A DENSITY OF 8 PER LINEAR FT. SHALL BE PLACED IN ALTERNATING LAYERS AND BUCKET COMPACTED AS IT IS CONSTRUCTED. WILLOW CUTTINGS SHALL SLOPE AT AN APPROXIMATE 2:1 SLOPE AS SHOWN IN SECTION VIEW. STEMS MAY OVERLAP. THE CUT ENDS SHALL BE PLACED AT THE BASE OF THE SLOPES WITH THE UNCUT ENDS EXTENDING BEYOND THE EDGE OF THE SOIL LIFT OR TRENCH SO THAT APPROXIMATELY ONE-THIRD OF THE TOTAL CUTTING LENGTH IS EXPOSED BEYOND THE FRONT EDGE OF THE BASE.
4. THE UPSTREAM AND DOWNSTREAM ENDS OF THE STRUCTURE SHALL TRANSITION SMOOTHLY INTO ADJACENT STREAMBANK STRUCTURES TO MINIMIZE EROSION, FLANKING, AND BANK FAILURE. STRUCTURE ENDS MAY BE STABILIZED WITH ADDITIONAL CATEGORY 2 ROCK AS DIRECTED BY ENGINEER.
5. AFTER INSTALLATION OF THE VEGETATED WOOD MATRIX, BACKFILL THE STRUCTURE WITH STOCKPILED MATERIAL TO FINISHED GRADE AND BUCKET COMPACT. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.



### MATERIAL SCHEDULE (PER LINEAR FOOT)

ITEM	QUANTITY
1 CATEGORY 4 WOOD	4
2 CATEGORY 3 WOOD	3
3 RIPARIAN CUTTINGS	5
4 STREAMBANK TOE GRADATION	0.17

## STREAMBANK TOE FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
10	95	D100
8	90-95	D95
6	85-90	D84
5	65-85	D65
4	50-65	D50
2	35-50	D35
1	20-35	D15
FINES	20	



### EXAMPLE OF A CONSTRUCTED VEGETATED WOOD MATRIX

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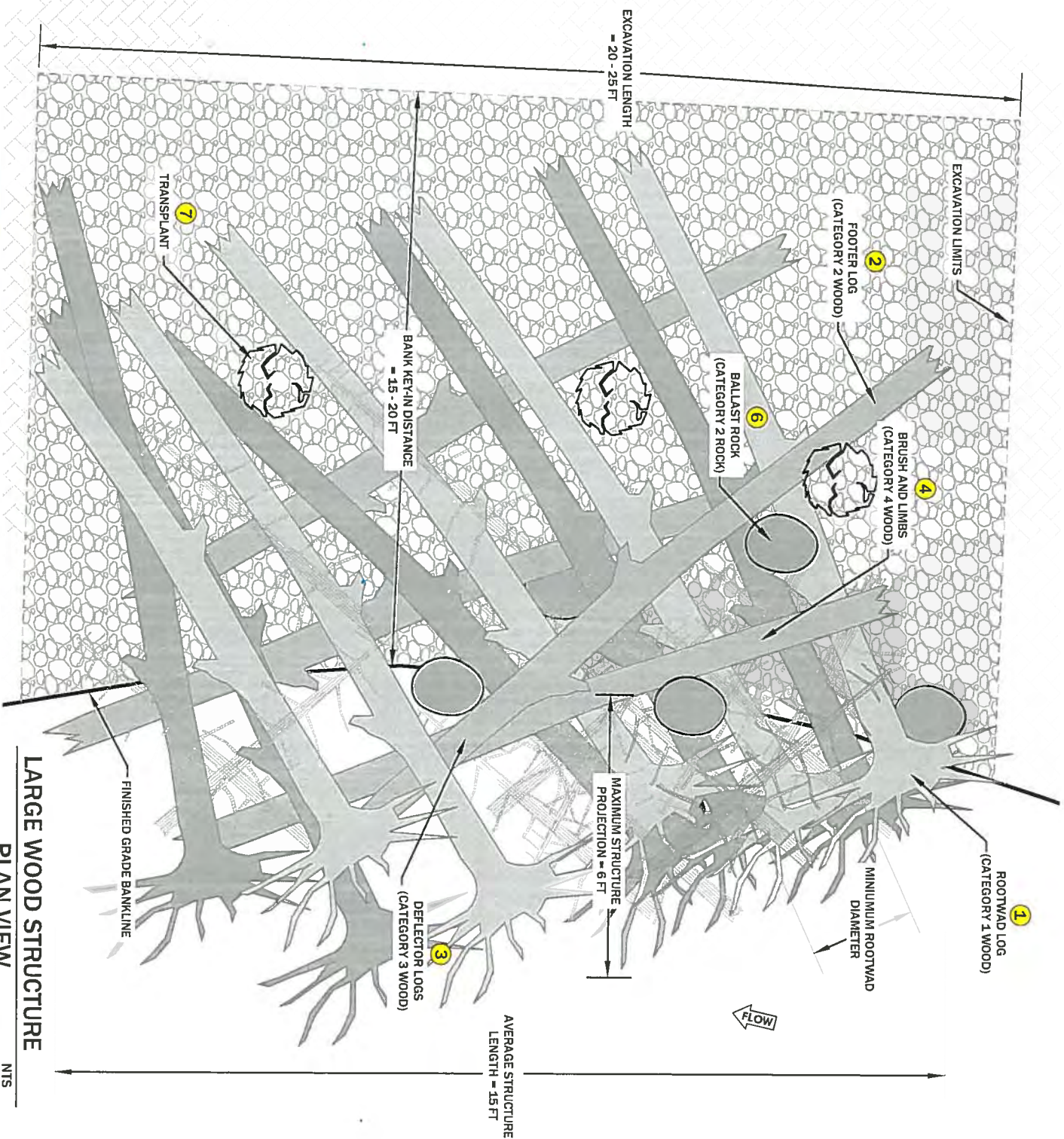
## VEGETATED WOOD MATRIX DETAIL



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## GENERAL NOTES

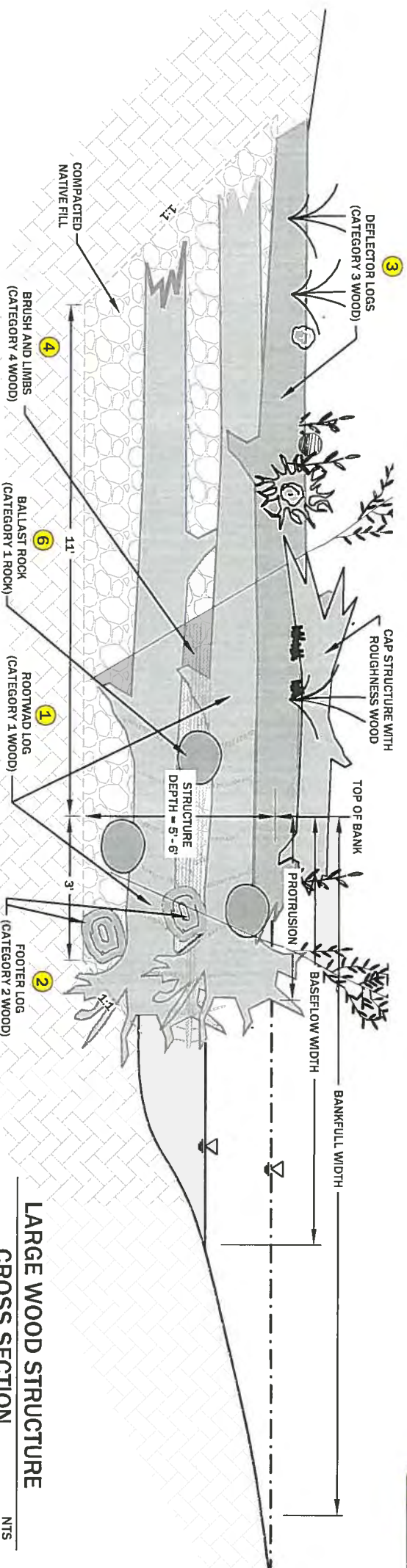
1. CONSTRUCTION OF THE LARGE WOOD STRUCTURE WILL OCCUR PRIOR TO INSTALLATION OF VEGETATED WOOD MATRIX STRUCTURE.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH LARGE WOOD STRUCTURE PRIOR TO CONSTRUCTION.

## NOTES ON LARGE WOOD STRUCTURE INSTALLATION

1. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. INSTALL TWO FOOTER LOGS (CATEGORY 2 WOOD) AT THE BASE OF THE EXCAVATED TRENCH AT THE ORIENTATIONS NOTED IN PLAN VIEW. FOOTER LOGS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
3. INSTALL THREE TO FIVE ROOTWAD LOGS (CATEGORY 2 WOOD) INTERSECTING BOTH FOOTER LOGS AT THE ORIENTATION NOTED IN PLAN VIEW. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL, AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 5-6 FT. BEYOND THE FINISHED BANK LINE.
4. BACKFILL TRENCH WITH STOCKPILED MATERIAL UP TO THE TOP OF THE FOOTER LOGS. BACKFILL SHALL BE BUCKET COMPACTED. PLACE CATEGORY 1 ROCK WHERE ROOTWAD LOGS INTERSECT FOOTER LOGS.
5. INSTALL A SECOND TIER OF TWO FOOTER LOGS (CATEGORY 2 WOOD) FOOTER LOGS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
6. INSTALL BRUSH AND LIMBS (CATEGORY 3 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
7. INSTALL THREE ROOTWAD LOGS (CATEGORY 2 WOOD) INTERSECTING THE LOWER TIER OF ROOTWADS AT THE ORIENTATION NOTED IN PLAN VIEW. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL, AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 5-6 FT. BEYOND THE FINISHED BANK LINE.
8. INSTALL BRUSH AND LIMBS (CATEGORY 3 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
9. BACKFILL TRENCH WITH STOCKPILED MATERIAL UP TO THE TOP OF THE ROOTWAD LOGS. BACKFILL SHALL BE BUCKET COMPACTED. PLACE CATEGORY 2 ROCK WHERE ROOTWAD LOGS INTERSECT LOWER ROOTWAD LOGS.
10. INSTALL DEFLECTOR LOGS (CATEGORY 2 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. DEFLECTOR LOGS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
11. PLACE AND BUCKET COMPACT STOCKPILED MATERIAL TO THE FINISHED BANK LINE. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.

**MATERIAL SCHEDULE  
(PER STRUCTURE)**

	ITEM	QUANTITY
1	CATEGORY 1 WOOD	10
2	CATEGORY 2 WOOD	6
3	CATEGORY 3 WOOD	10
4	CATEGORY 4 WOOD	10
5	RIPARIAN CUTTINGS	75
6	CATEGORY 2 ROCK	6
7	TRANSPLANTS	3



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**SHEET NUMBER**

DT-5



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## LARGE WOOD STRUCTURE DETAIL



Category	Item	Quantity	Units	Diameter	Length	Rootwad
Wood	Category 1 Wood	30	ea	12 in - 18 in	25 ft	Yes
	Category 2 Wood	18	ea	10 in - 12 in	15 - 20 ft	Optional
	Category 3 Wood	2,280	ea	6 in - 10 in	10 ft	No
	Category 4 Wood	3,030	ea	< 6 in	10 - 15 ft	No
	Riparian Cuttings	4,425	ea	0.25 in	6 ft - 8 ft	No
Category	Item	Quantity	Units	Diameter		
Rock	Category 1 Rock 30"-36"	125	ea	30"-36"		
	Category 2 Rock 24"-30"	138	ea	24"-30"		
	Streambank Toe Fill	128	cy	see gradation (sheet DT-4)		
	Streambed Fill	107	cy	see gradation (sheet DT-2)		
Category	Item	Quantity	Units	Quantity	Units	
Misc.	Transplants	14	ea			
	8oz Amoco ProPex4553 Nonwoven Needle punched (felt Geotextile) (sf)	3,500	sf	259	If	
	5' Slide Gate	1	ea			
	24" CMP (TO BE DETERMINED)	40	If			

MATERIALS LIST



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